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THIRD SUPPLEMENT

TO THE

CRAG MOLLUSCA,

COMPRISING

TESTACEA FROM THE UPPER TERTIARIES OF THE EAST OF ENGLAND.

BY THE LATE

SEARLES V. WOOD, F.G.S.

EDITED BY HIS SON SEARLES V. WOOD, F.G.S.

PREFACE; PAGES 1—24; PLATE I.

UNIVALVES AND BIVALVES.

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PREFACE BY THE EDITOR.

My late father had at the time of his death (which took place on Oct. 26th, 1880 ollected some materials and written the text for a further short Supplement to his riginal work on the "Crag Mollusca." These materials and text consisted of the escriptions here given, and also of those of the remains of certain vermiform mollusca which he had got together from the Coralline and Red Crag beds. The latter, however, were not left by him in such a form as would allow me to give his views without risk of misrepresentation; and as I know, moreover, that in respect of one at least of these forms he was in great doubt to the last, whether it belonged to the Molluscous sub-kingdom at all, I have thought it best to suppress that portion of his notes, and to give only the portion which relates to the Gasteropoda and Bivalvia; as to which I well know what his ideas were. This part forms but an insignificant addition to the preceding portions of his work, and comprises for the most part only shells that have got into the Red Crag beds by derivation from older formations; but as all such shells must be considered, and eliminated from the evidence which is obtainable to show of what the molluscan Fauna of that part of the North Sea which washed the shore of East Anglia at the time of the Red Crag really consisted, their description and representation by figure, as my father intended, appear to me to form a proper sequel to his work.

The text which is not comprised by brackets is that left by my father. The text within brackets (with the exception of the description of *Margarita crassi-striata*, and of the bed at Boyton from which that shell was obtained, which is by Mr. Robert Bell, is by myself.

THIRD SUPPLEMENT TO THE CRAG MOLLUSCA.

GASTEROPODA.

ROSTELLARIA? GRACILENTA, *S. Wood.* 3rd Sup., Tab. I, fig. 1.

Axis, 1 inch.

Locality. Red Crag, Felixstowe.

Many years ago I found a few specimens in the Red Crag at Sutton, to which I gave the provisional name of *Rostellaria plurimacosta* in my original Catalogue in 'Mag. Nat. Hist.,' September, 1842, p. 543. Not finding any of the like form and character in better preservation I, in the first supplement (1872) to my work on the 'Crag Mollusca' (p. 5, Tab. II, fig. 14), gave a figure with the best information I possessed respecting the few specimens in my own cabinet, and referred them (doubtfully) to a well-known Eocene species *R. lucida*, J. Sow.

In my recent researches at Felixstowe I have obtained three or four more specimens of this shell, though in a more mutilated condition. With these I have found some other mutilated specimens, the best of which I have here had figured. This resembles in its ornamentation the Eocene species *lucida*, which is from the upper part of the London Clay ('Min. Con.,' Tab. 91), but it differs in other respects, as it is much more slender, more elongated, and possesses larger and fewer costulæ. Unfortunately the mouth or aperture is imperfect so that the genus cannot with certainty be determined. I, however, propose for it provisionally the name above. It is undoubtedly an immature specimen, with its outer lip sharp as it would naturally be in a young and growing shell.

In the Ipswich Museum there is a mass of material, nearly two feet across and about three inches in thickness, found in the nodule bed at the base of the Red Crag at Waldringfield, and on the upper surface are a large number of specimens of a vermiform shell identical with what has been figured in 'Min. Conch.,' Tab. 596, figs. 1—3, as *Vermetus Bognoriensis*, and with them are several specimens, but in a mutilated condition, of what may be referred to *Rostellaria lucida*, as also some specimens resembling my present shell in a similar condition to my own above figured. There can

therefore, I think, be little doubt but that the shell now figured is like the true *lucida*, a London Clay species, and has got into the Crag by derivation from that formation; for the shell figured by Sowerby in Dixon's 'Geology of Sussex,' Tab. V, fig. 21, from the Bracklesham beds as *R. lucida*, differs from that originally figured by him under this name in 'Min. Con.' (and which was from the London Clay of Highgate), and, in my opinion, is specifically distinct from it, as it possesses more numerous and sharp ribs or costulæ, and is more regularly striated in a spiral direction, the striations covering the entire surface.

TROPHON ANTIQUUS, var. DESPECTUS. 3rd Sup., Tab. I, fig. 9.

MUREX DESPECTUS, *Linn.* Syst. Nat., edit. xii, p. 1222, 1766.
FUSUS — *Lam.* An. sans Vert., 2nd ed., tom. ix, p. 448, 1843.
— — *Fleming.* Brit. Anim., p. 349, 1828.
TRITONIUM DESPECTUM var. ANTIQUATA, *Middendorf.* Malkop., p. 135, 1849.

Locality. Red Crag, Sutton.

In the first portion of my work I have given many of the extreme forms of this variable species, but there is no figure representing the front or opening of the present variety; and as the above name of *despectus* has been several times given as a distinct species from the Red Crag I have thought it necessary to represent a shell here which resembles the recent form of that name. This was introduced as a distinct Crag species by the late Sir Chas. Lyell in a list accompanying a paper by him, and published in the 'Mag. Nat. Hist.' in 1839, p. 329; by the late Edward Forbes, also, in his Memoir in the 'Geol. Survey,' 1846, p. 426, and in the list by Professor Prestwich in 'Quart. Journ. Geol. Soc.,' vol. xxvii, p. 488. I think it therefore incumbent on me to give the accompanying figure of this variety, for such only do I conceive it to be. I will, therefore, refer to Plate V of my first volume, and assign the figures therein as the following varieties of this species according to my view, viz. *Fusus decemcostatus*, Gould, 'Invert. Massach.,' is represented in it by fig. 1 *a*; *Fusus carinatus*, Lam., by fig. 1 *b*; *Fusus striatus*, Sow., by fig. 1 *c*; *Fusus contrarius*, Phil. and Nyst, by figs. 1 *d*—*k*.

There are some other varieties, I believe, in the Crag of which I have not been able to obtain specimens for representation. *Fusus tornatus*, Gould, is, I believe, only a variety of *T. antiquus*, and the shell figured in the 'Ency. Method.' with wavy ridges, pl. 426, fig. 4, is another variety, and this I am told has been found in the Red Crag, but I have not been able to see a specimen or I would have had it figured. Brown, in his 'Illustr. Brit. Conch.,' pl. 47, figs. 10 and 13, has figured this shell with wavy ridges, and calls it *Fusus subantiquatus*, but says, "I have great doubts of this being

a British shell." This undulation is produced by a sinuated form of the outer lip, and is probably a distortion, and if so the specimens are not likely to be very numerous.

TROPHON MURICATUS, *Mont.* Crag Moll., vol. i, p. 50, and 1st Sup., p. 28.

TROPHON MURICATUS var. EXOSSUS. 3rd Supplement, tab. i, fig. 3, 1882.

Locality. Red Crag, Felixstowe.

The specimen figured as above was recently found by me, and though in excellent preservation is quite destitute of the longitudinal ribs present in the ordinary form of this species. I have therefore distinguished it as a variety, under the name of *exossus*.

PLEUROTOMA TURRIS, *Lamarck*, 3rd Sup., Tab. I, fig. 8.

PLEUROTOMA TURRIS, *Lam.* An. sans Vert., tom. vii, p. 97, 1822.
— — — Ibid., 2nd ed., tom. ix, p. 367, 1843.
— — — Ency. Method., p. 795, t. 441, fig. 7, 1832.
— — *Nyst.* Coq. foss. de Belg., p. 525, 1843.
MUREX INTERRUPTUS, *Brocchi.* Conch. foss. Subap., p. 433, pl. ix, fig. 21, 1814.

Spec. Char. "*T. fusiformi-turrita, transversim sulcato-rugosa; striis longitudinalibus tenuissimis in areis planulatis per undulatis; anfractibus, infra medium ungulatis, ultra angulum plano-concavis, prope suturas marginatis.*"

Axis, 1½ inch.

Locality. Red Crag, Felixstowe.

There is some confusion respecting the name of this species. Lamarck described two species as *interruptus*, one a recent and very distinct shell, the other a fossil for which he adopted the specific name of (*Murex*) *interruptus*, referring it to the *Murex interruptus* figured and described by Brocchi in 1814; but a shell named *Murex interruptus* had been described by Pilkington in 'Trans. Linn. Soc.,' for 1804, vol. vii, T. 11, f. 5 (and also figured in 'Min. Conch.,' T. 304), which takes precedence and is entitled to that specific name. I have therefore adopted the above specific name of *turris* for the fossil from the Red Crag, Pilkington's species being a British Lower Tertiary form, and quite distinct from our present shell which is a Bolderberg and Italian species.

Bellardi has represented two shells under the name of *Pleurotoma interrupta*, considering them only as varieties of the same species, and the specimen from the Red Crag at Waldringfield, figured in my first Supplement, T. V., f. 1, seems to corres-

pond with his variety C, given in fig. 11 of Tab. I of his work, while the present shell corresponds with his fig. 16 of the same plate. [Our specimen therefore seems to have got into the Red Crag from some bed corresponding to those of the Bolderberg.—Ed.]

I found also among my siftings in the Red Crag at Felixstowe a considerable portion of a specimen of a species belonging to this genus with very distinct ornamental ridges or costæ which appears to correspond or at least to approach nearer to *Pleurotoma abnormis* of F. Edwards, 'Eocene Mollusca,' p. 294, Tab. XXX, fig. 14, *a. b.*, than to any other species I have compared it with. This being a London Clay species it may have come into the Red Crag with the *Rostellariæ* which I have figured. I also obtained a fragment of what seems to be *Pleurotoma Gastaldi*, Bellardi, Tab. II, fig. 19, but neither of them being in a condition to allow of correct determination I have not thought it worth while to have them figured.

Fig. 5 of Tab. I, represents one of two small specimens kindly sent to me by Dr. Reed with the name of *Pleurotoma gracilior*, A. Bell, from the Red Crag of Walton Naze affixed to it. These appear to have lost their outer coating, but are the same as the shell represented in fig. 12 of Tab. VII of vol. i of 'Crag. Moll.,' under the name *lævigata*, Phil., and which at p. 41 of my first Supp., is referred to *P. tenuistriata*, A. Bell. One of them has the upper whorls destroyed, but the other has all the whorls perfect and so peculiar that I have had it represented. It shows not only an obtuse apical region, but the first volutions are wholly different from the more cylindrical volutions of the rest of the shell.

Pleurotoma nebula, *Mont.* 3rd Supp., Tab. I, fig. 7.

Fusus ? nebula,	*S. Wood*	Catal. Mag. Nat. Hist., p. 541, 1842.
Clavatula —	—	Crag Moll., vol. i, p. 60, tab. vii, fig. 10, 1848.
Pleurotoma —	—	1st Supplement, p. 45, tab. vii, fig. 7, 1872.
Mangelia —	*Forb. & Hanl.*	Brit. Moll., vol. iii, p. 476, pl. 114, figs. 7—9, 1853.

Although I have already given two figures of the Crag shell under the above specific name, they neither of them show a satisfactory representation of this long known species, and I have therefore determined to give another of a specimen in a more perfect condition from the cabinet of Mr. Robert Bell, which has retained some of its spiral striæ.

PLEUROTOMA HARPULA, *Brocchi*. 3rd Suppt., Tab. 1, fig. 4.

MUREX HARPULA, *Brocchi*. Conch. foss. Subap., p. 421, tab. viii, fig. 12, 1814.
PLEUROTOMA — *Phil.* En. Moll. Sic., vol. ii, p. 173, 1844.
FUSUS — *Risso*. Hist. Nat. Europe Mérid., vol. iv, p. 208, 1826.
RAPHITOMA — *Bellardi*. Monog. de Pleurot., p. 101, No. 22, 1847.

Axis, $\frac{9}{10}$ of an inch.

Locality.—Boyton.

A single specimen has been sent to me for examination and illustration by Mr. Robt. Bell, with Brocchi's specific name attached, and in this assignment I quite coincide. It appears in shape to be intermediate between *Fusus* and *Pleurotoma*, but probably only doubtfully to be entitled to the above generic position, as it seems quite destitute of the "side slit" of that genus. Our shell may be described in the words of Brocchi, viz.: "Testa turrita, longitudinaliter costata costis (8—9) tenuis, spiraliter striatis, interstitiis lævigatis, anfractibus convexiusculis, apertura ovata; cauda brevissima aperta.

RAPHITOMA SUBMARGINATA, *Bellardi*. 3rd Suppt., Tab. 1, fig. 2.

PLEUROTOMA SUB-MARGINATA, *Bonelli*. Cat. Mus., *fide* Bellardi.
RHAPHITOMA — *Bellardi*. Monog. Pleurot. foss., p. 95, tab. iv, fig. 20, 1847.

Axis, $\frac{6}{10}$ of an inch.

Locality.—Red Crag, Felixstowe.

A single specimen, but unfortunately not quite in perfection, has been found in my siftings of the Red Crag material at Felixstowe, and I have referred it as above, but my dependence for so doing has been upon the description and figure by Bellardi, not having a specimen of the Italian fossil for comparison. My shell appears to be somewhat intermediate between this and *R. plicatella*, but I have no doubt that it is one of the very large group of fossil shells varying in some trifling degree only which connect the genus *Pleurotoma* and *Fusus*, and for which I believe nearly twenty generic divisions have been proposed. My shell is not far removed from *Murex vulpeculus*, Brocchi, and *Pleurotoma Maggiori*, Phil., forms. which, I think, might without any impropriety be specifically united. My shell measures six-tenths of an inch in length, and two-tenths in its diameter, without any ridges or folds upon the columella, or any denticulations

on the inside of the outer lip; but this may be from its not having arrived at maturity. There are traces of spiral striæ, but the specimen has had its surface much eroded, and when perfect it was probably fully covered. It has about a dozen costulæ or riblets on the last volution. [The specimen appears to me to be a derivative.—Ed.]

COLUMBELLA ERYTHROSTOMA? *Bonanni.* 3rd Suppt., Tab. 1, fig. 10 *a*, *b*.

COLUMBELLA ERYTHROSTOMA, *Bon.* *Fide* Bellardi Monog. delle Columbelle foss. del Piedmonte, p. 9, fig. 4, 1848.

Spec, char.—"*Testa turrito-elongata, turgidula, anfractibus lævibus, convexiusculis; ultimo magno: apertura dilatato-elongata, labro subarcuato, subvaricoso; columella adnata, regulariter et numerose rugosa; rugis brevibus externis.*"—Bellardi.

Locality. Red Crag, Butley.

The above figures represent specimens found by myself some years ago, in the Red Crag of Butley, which I have hitherto left unnoticed, regarding them merely as specimens of *C. sulcata*, Sowerby, derived from an older part of the Red Crag, and worn smooth in consequence, that species being abundant at Walton, and variable in length; one figured in Supplement to Crag Moll., p. 9, Tab. 11, f. 16, measuring one inch and five-eighths, while another is less than three-quarters of an inch, both of them being full-grown, and belonging, I believe, to the same species.

The specimens now figured are quite smooth, a character agreeing with that which Bellardi has given for the Italian fossil *erythrostoma*, which is described as "*anfractibus lævibus;*" but if my specimens have been derived from an anterior Red Crag bed, they may have lost the spiral striæ from either decortication or abrasion, and so be, as I originally supposed them to be, merely worn specimens of *C. sulcata*. Mr. A. Bell gives three specimens of this genus from what he terms the Middle and Upper Crag, viz. *C. sulcata*, *C. abbreviata*, and *C. Borsoni;* and another is added in Prof. Prestwich's catalogue of mollusca from the Red Crag, viz. *C. scripta*. In my original work, and in the supplements thereto, I have figured several different forms of what appear all to be *C. sulcata;* and as two specimens, which had been furnished him by Mr. A. Bell, under the name of *Columbella abbreviata*, have been kindly sent to me by Dr. Reed, I have figured one of them (Tab. 1, fig. 6), in order that a representation of the shell, on the strength of which this name of *abbreviata* has been introduced into the list of Red Crag Mollusca, may appear. The shorter of the two specimens which I have figured under the name of *erythrostoma* (fig. 10A), agrees with this *abbreviata*, but is smooth.

LACUNA (MEDORIA) TEREBELLATA, *Nyst.*

MELANIA TEREBELLATA,	*Nyst.*	Coq. foss. de Belge, p. 413, pl. xxxviii, fig. 12, 1843.
PALUDESTRINA	—	*S. Wood.*	Crag Moll., vol. i, p. 109, tab. xii, fig. 7, 1848.
EULIMENE	—	—	1st Supplement, p. 65, 1872.

This shell was figured by myself in the 'Crag Moll.' under the generic name of *Paludestrina*. In my first Supplement I, in my perplexity, grouped it in a new genus, in which I proposed to embrace another crag shell, viz., *Eulimene*. It is not, I think, either a freshwater or an estuarine shell, neither does it belong either to *Paludina* or to *Littorina*.

In the Red Crag at Felixstowe I have lately obtained more than a hundred specimens, varying in the length of axis from an eighth of an inch to upwards of five eighths, every one of which is in a mutilated condition, but all belonging to this species (whatever it may be); and every one has, more or less, its umbilicus (lacuna), covered over, by apparently, an extension of the left lip of the shell. This extremely mutilated condition evidently indicates that the specimens have been introduced into the Red Crag both at Walton and elsewhere from some older bed, but I have not been able to trace whence. They are very thick and strong shells, more so than any freshwater species in this country.

[The shell is described by M. Nyst, in his 'Coq. foss. de Belge,' as occurring at Antwerp and Calloo, and as being rare, but he does not there specify in what division of the Upper Tertiaries at these places the shell is found. In his 'Listes des Fossiles des divers Etages,' p. 424, however, he gives it from the Crag jaune (or uppermost crag) only. I do not find it in any of the lists given by M. Vanden Broeck, in his 'Esquisse Geologique,' for the different horizons which he seeks to establish of the beds at, and in the neighbourhood of Antwerp.—ED.]

In the 'Crag Moll.,' vol. i, p. 108, Tab. XI, fig. 2 *a*, *b*, is figured and described a shell from Bramerton, under the name of *Paludestrina subumbilicata*, which may, I now think, be regarded as the ancestor of the living *ventrosa*, and it is there stated that in my cabinet was one specimen from the Cor. Crag, the identity of which was given as doubtful in consequence of the Bramerton shell (*subumbilicata* or *ventrosa*) being generally considered a freshwater or estuarine inhabitant. This species, however, as well as *ulvæ*, is capable of living where the water is not quite fresh, and I have lately found in the purely marine Red Crag of Felixstowe a few specimens which appear to me undistinguishable either from the Bramerton shell, or from the living species, called by the British Conchologists *Hydrobia ventrosa*. If we may depend upon figures and descriptions, there are several continental shells with different names (both generic and

specific) which cannot be separated from the Crag and recent shell above referred to, but of these some are given as fossils from deposits that are said to be purely of freshwater origin, while others are given as from beds of purely marine origin. This species so closely resembles some of those of *Rissoa*, that I do not know any character in the testaceous part by which it can be separated from that genus.

NODOSTOMA ORNATA, *S. Wood.* 'Crag Moll.,' vol. i, p. 87, Tab. IX, fig. 6, as *Odostomia simillima;* 1st Sup., p. 64, as *O. ornata;* 3rd Sup., Tab. I, fig. 13.

Locality.—Cor. Crag, Sutton.

This pretty little shell was figured and described in the 'Crag Moll.," under the name of *Odostomia simillima*, and was assigned to Montagu's species *simillimus*, which I now consider was erroneous; and in my first Supplement I assigned it as distinct, and gave it the name *ornata*. The obscure tooth, stated in my first volume (p. 87) as present upon the columella, is, I find, only a fragment of sand adhering to the columella, while the aperture is more elongately ovate than in *Odostomia*, and of quite a different form from that in *Chemnitzia*. My specimens were very few and somewhat variable, but the species, I think, cannot be placed in the genus *Odostomia*, being apparently intermediate between that genus and *Eulima*. I therefore propose to call it *Nodostoma*[1] from its evident relationship with *Odostomia*, but separated from it by its toothless character.

The shell described by Montague is considered by the authors of 'Brit. Moll.,' as well as by the author of 'Brit. Conch.,' to have been "a bleached and worn specimen" of *Chemnitzia rufa*, Phil., and doubtfully British. The present figure is taken from a single specimen that I have recently found, the shell being extremely rare.

NODOSTOMA EULIMELLOIDES, *S. Wood.* 3rd Sup., Tab. I, fig. 14.

Locality.—Cor. Crag, Sutton.

[Of the specimen figured as above, a sketch was made by my father for his intended plate under this name; and he appears to have intended to give it as a second species of his new genus, *Nodostoma*, but he has left no other MS. respecting it beyond the above specific name of *eulimelloides*. I have compared it with all the species of *Eulima* described by him from the Crag, and it agrees with none satisfactorily. It comes nearest to *Eulima glabella*, but the form of the mouth differs, the whorls are more cylindrical,

[1] Νωδος, toothless, and στομα, mouth.

and the suture is deeper or more marked. The surface is smooth and without any ornament. Though imperfect by the loss of the upper whorls, the specimen is otherwise in good preservation, and shows these distinguishing characters clearly.—Ed.]

Menestho ? Suttonensis, *S. Wood.* 3rd. Sup., Tab. I, fig. 11.

Locality.—Cor. Crag, Sutton.

The above figure represents a small shell found by myself some years ago and retained until now in the hope of obtaining a better specimen. I have referred it to the genus *Menestho*, as to which I have made some remark at p. 56 of my first Supplement.

My shell is unfortunately not quite perfect, the outer lip being slightly broken, but it much resembles the opening of *Rissoa* or *Odostomia*. The specimen is covered with four rather coarse spiral lines and depressions on the lower whorl, and three on the next above this, but probably it may not be a full-grown shell. The nearest figure to which I have been at all able to refer it (approximately) is a very small shell, described by Isaac Lea in his contributions to 'Geology,' pl. iv, fig. 84, under the name of *Pasithea sulcata*, but, judging from this figure, my shell is distinct. Lea gives no less than nine species under that generic name, several of them differing materially in characters that it would be difficult to collect into one genus, and he does not specify which of these he regards as the type of his genus *Pasithea*, so that I am unable to adopt that genus for my present species.

Odostomia Reevei, *S. Wood*, 3rd Supp., Tab. I, fig. 12.

Locality. Fluvio-marine Crag, Bramerton.

The above figure represents a specimen of the above-named genus sent to me by Mr. Jas. Reeve, of the Norwich museum and found by him at Bramerton in the bed which yielded the specimens of *Cerithium derivatum* and *Odostomia derivata* described in the 'Second Supplement to the Crag Moll.' (pp. 39—40). The nearest species to which I can compare it is *O. dubia*, Jeff., but it differs sufficiently, I think, to be considered distinct, at least as much so as several of our so-called British species. The shell is somewhat thick and free from striæ of any kind, the aperture measures half the length of the entire shell, and is of a very ovate form, the base of it being contracted more than usual in any species of this genus. The shell is rather larger than any of my specimens from the Cor. Crag, with the exception of *O. conoidea* and *O. turrita*, which have eleven volutions while the present shell has not more than four, or perhaps five.

In the 'British Mollusca," and in the 'British Conchology,' there are more than twenty *Odostomiæ* described as distinct species, each with very slight differences of character; but whether they are all specifically distinct is perhaps questionable. The Authors of 'British Mollusca,' vol. iii, p. 260, justly say: "The species are difficult to distinguish and very critical." I have figured several so-called species under this generic name and I have in most cases assigned them from the figures and descriptions of these Authors, and of the Author of 'British Conchology,' as they had better means for determination than I have had.

[The specimen figured is probably one which has been carried into the fluvio-marine Crag from the same bed as that which supplied *Cerithium derivatum* and *Odostomia derivata*.—ED.].

[The following description of a new species and some remarks as to the bed at Boyton, in which it occurred, have been kindly supplied by Mr. Robert Bell.—ED.]

[MARGARITA CRASSI-STRIATA, *Robt. Bell.* 3rd Sup., Tab. 1, fig. 15.

Locality. Boyton.

Shell small, very solid, somewhat conical; whorls five; suture deep, each volution having four or five thick revolving ridges with traces of fine intermediate ridges. These are crossed by prominent lines of growth, giving them a slightly crenulated appearance. The base is, like the whorls, rounded and strongly ridged, with a very small umbilicus. Mouth rounded, with an obscure tooth or fold near the base of the columellar lip.

The species which seems nearest to it is *Margarita cinerea*, Couthuoy, but it differs in having much stronger ridges, especially at the base, and a smaller umbilicus. The upper whorls also do not seem to have that lattice-like appearance which is present in well-preserved specimens of *M. cinerea*.

It is difficult to indicate which formation this shell belongs to. The section of Crag worked at Boyton can seldom be seen, being an excavation close to the Butley River, and mostly from three to six feet under water, the coprolite diggers standing in the water when at work, and scooping up the sand from the bottom of the trench; but from what I have been able to observe, and from an examination of a large number of species found there, the formation seems to range from the fossiliferous beds of the Coralline (Zone d. of Prestwich's section in his paper on the "Crag Beds of Suffolk and Norfolk," 'Quart. Journ. Geol. Soc.,' vol. xxvii, p. 121,) up to the middle portion of the Red Crag. Probably some of the beds have been reconstructed from the wearing away of the Upper Coralline strata on the other side of the river, although a bed of the larger bivalves

Astarte, Cardita, &c.) was seen some few years ago *in sitú* at the base of the excavation, in a part now filled in, and I have obtained many double shells from there exactly answering to those found in the pits at Broom Hill, Sudbourn, and at Sutton. There seems also to be an admixture of shells from some formation with which we are unacquainted in England (most probably the Belgian Crag) as several species have been found here that have not been detected in any other Crag bed (*Fusus Waelii, Murex Reedii,* &c.). The Red Crag element is, however, sufficiently prevalent, and such shells as *Trophon scalariformis, T. muricatus,* and especially *Nassa reticosa,* are particularly abundant.[1] The specimen of *Amaura candida* mentioned in the column of remarks in the list of Mollusca given in the first 'Supplement to the Crag Mollusca,' as found at Boyton, came, I believe, from Butley, *i. e.* from the same locality as the specimen figured in Tab. I, fig. 3, of that Supplement. Robt. Bell.]

BIVALVIA.

SILIQUARIA PARVA, *Speyer.* 3rd Sup., Tab. I, figs. 16 *a—b.*

SILIQUARIA PARVA, *Speyer.* Ober.-Oligoc. Tertiar. Detmold., p. 33, tab. iv, fig. 2 *a, b,* Palæontographica, Band xvi, 1869.

Spec. Char. "*Testa parva tenuissima, oblonga, antice brevis, postice producta, utrinque æqualiter rotundata, lævigata, nitida; cardo subumbone parvulo fossula plana instructus, dente unico munitus. Nymphæ breves angustæ.*" Speyer.

Locality. Bramerton.

Two fragmentary specimens of a small bivalve were sent to me by Mr. Jas. Reeve (as mentioned in my second Supplement, p. 40), which I thought were too small and imperfect to be represented, but as they appear to be indicative of the presence in Norfolk of an older formation than the one in which they have been found, I think it desirable to figure them, imperfect as they are. The hinge has a prominent fulcrum for the support of its external connector, the central tooth large, prominent, and obtuse, being immediately before it and under the umbo; and there is a depression in the corresponding valve for its reception[2] similar to the hinge furniture of *Saxicava,* which it much resembles, as it does also the shells of *Sphenia,* but there appears, I think, sufficient difference to

[1] [See also footnote to p. 3 of Second Supplement as to this Boyton bed, the information quoted there having been obtained from Mr. Alfred Bell. From that it would appear that the bed containing *Astarte* and *Cardita* was part of the lowest portion of the Coralline Crag, and was overlain by some Red Crag; the shells of both formations becoming thus intermingled in the working.

[2] The engraver has not been successful in delineating the character of the hinge in either valve. The generic name *Siliquaria* is used here from Speyer, but it is that also of a vermiform shell.—ED.]

justify a generic distinction. The hinge more resembles that of the latter shell, but that species (*Sphenia*) has an internal connector. The name of *Siliquaria* (of Schumacher), as given to the Oligocene shell by Dr. Speyer, is, I think, sufficient to guide us in our future determination, for although I have many hundreds of specimens of *Saxicava* of small size from the Coralline Crag, I have nothing that will fairly correspond with the present shell.

[The specimens have probably got into the Fluvio-marine Crag of Norfolk from the same formation there which supplied those of *Cerithium derivatum*, *Odostomia derivata*, and *Odostomia Reevii*.—Ed.]

Cardium echinatum, *Linn.* Crag Moll., vol. ii, p. 152.

As stated at p. 152 of my second volume this species has very rarely occurred in the Crag, but a specimen has lately been found at Felixstowe by Mr. W. E. Hardy, of Park Crescent, Stockwell, which was sent to me for verification, and it is similar to the one (now in the British Museum) figured in the 'Crag Moll.,' vol. ii, p. 152, Tab. XIV, fig. 3. It belongs probably to the variety called *ovata* by Dr. Jeffreys in 'Brit. Conch.,' vol. ii, p. 271, and described by him as having the "ribs sharp." The Crag shell has triangular ribs (unlike the common recent species, on which the ribs are quadrate), with spines in a slight depression down the centre of these. The species is very rare in my collection, I having found no other specimen than the one I gave to the British Museum. This specimen is in good preservation with the exception of having lost all its spines. I have a shell from the Sicilian beds which it more resembles, with sharp angular ribs covered with broad spatulate imbricated spines, but Mr. Hardy's specimen, though well preserved otherwise, has lost all. I do not know whether this Sicilian fossil has ever been figured.

Pecten disparatus, *S. Wood.* 3rd Suppt., Tab. I, fig. 17.

Locality. Red Crag, Waldringfield.

The shell as above represented has been sent to me by Mr. R. Bell, but without a name, and I know not to what published species it can be justly referred. I thought at first that it might be one of the many varieties of that variable shell *P. Danicus* (*septem radiatus*), but I have not been able to find one precisely similar in character; and although there is much resemblance to two or three other species, I have not been able to assign it satisfactorily to any one. I have therefore given to it provisionally the above

name. It is somewhat similar to *P. multicarinatus*, Lam., figured and described by the late Dr. Deshayes, 'Descr. de Coq. foss. des Env. de Par.,' p. 307, Pl. XLII, figs. 17, 18, 19, but that is not quite so large a shell, and is said to be from Parnes, in the upper portion of the Paris Eocene. It differs essentially from *P. duplicatus*, on which the ribs are nearly uniform in size. Our shell is nearly orbicular, covered with ten or twelve large and slightly prominent convex rays, upon which, and also between them are three smaller rays, and between each of these is an alternate smaller one, so that between each of the most prominent there are seven smaller. All of these are ornamented with sharp imbrications, and the shell has unequal auricles, which in our specimen are not quite perfect; but there are indications of these being of large size in the perfect shell. In the interior of this valve, which is the right one, there are eight or nine furrows corresponding to the elevation of the prominences of the larger ribs. The muscle mark is not very distinct. This specimen, is, in all probability, a derivative from an older formation.

OBSERVATIONS AS TO THE SUCCESSIVE FORMATION OF THE BEDS FORMING THE APPARENTLY HOMOGENEOUS AND SYNCHRONOUS MASS OF "RED CRAG," AND THE ILLUSORY CHARACTER OF THE EVIDENCE AFFORDED BY PART OF THE ORGANIC REMAINS IN THEM.

Having in a previous portion of my work on the Crag Mollusca expressed my opinion of the distinctive character of the beds at Walton Naze from the main portion of the Red Crag, and of their older age, I took the opportunity of a few months' stay at Felixstowe in 1879-80 to thoroughly sift and search a large quantity of the Red Crag there, to ascertain not merely what species of Mollusca could be detected in it, but also the general condition in which the remains of these were preserved, so as to compare them with those at the Walton Naze locality, with which, from many visits to that place in the earlier years of my study of the subject, I was very familiar.

The following list is the result of that investigation; and in it I have affixed to those species which appear to me to have come into the Red Crag of Felixstowe only by derivation from beds older than the Red Crag (including those of the Coralline Crag,) the letter D, while to those which appear to me to have come only by derivation from earlier beds of Red Crag age, such as that at Walton Naze, I have affixed the letter W, the exclusively fragmentary condition of some species being indicated by the letter F.

Remains of Mollusca[1] found in the Crag of Felixstowe.

Gasteropoda.

Cypræa Europea, *Mont.*
— avellana, *J. Sow.*, W.
Voluta Lamberti, *J. Sow.*, F, D, W.
Terebra inversa, *Nyst*, F, D.
— canalis, *S. Wood*, F, D.
Columbella sulcata, *J. Sow.*, F, W.
Cassidaria bicatenata, *J. Sow.*, F, D.
Nassa granulata, *J. Sow.*
— incrassata, *Müll.*
— consociata, *S. Wood*, F, D.
— propinqua, *J. Sow.*
— pygmœa, *Lam.*
— labiosa, *J. Sow.*, F, D.
— reticosa, *J. Sow.*, W. and mostly F. or imperfect.
Rostellaria lucida, *J. Sow.*, F, D.
gracilenta, *S. Wood*, F, D.
Buccinum Dalei, *J. Sow.*
— undatum, *Linn.*
Purpura lapillus, *Linn.*
— incrassata, *J. Sow.*
— tetragona, *J. Sow.*, F, W.
Murex tortuosus, *J. Sow.*, F, D.
Trophon antiquus, *Linn.*
— — id. *var.* contrarius.
— alveolatus, *J. Sow.*, F, D.
— costifer, *Nyst*, F, W.
— altus, *S. Wood.*
— gracilis, *Dacosta.*
— muricatus, *Mont.*
— — id. *var.* exossus.
— Olavii, *Beck.*
— scalariformis, *Gould.*
Pleurotoma interrupta, *Broc.*, F, D.
— turricula, *Mont.*
Pleurotoma Trevelyana, *Turt.*
— scalaris, *Möll* (one specimen full size and perfect).
— nebula, *Mont.*
— costata, *Dacosta.*
Cancellaria scalaroides, *S. Wood*, F, D.
— (Admete) viridula, *Fab* (one specimen broken).
Cerithium tricinctum, *Broc.*, F.
— variculosum, *Nyst* (one whirl only), F, W.
— granosum, *S. Wood?* F, W.
Aporrhais pespelicani, *Linn.*, F, D. (very worn fragments).
Turritella incrassata, *J. Sow.*, F. and mostly D.
Scalaria funiculus, *S. Wood*, F, D.
— foliacea, *J. Sow.*, F, D.
Chemnitzia internodula, *S. Wood.*
Eulima intermedia, *Cant.*, D and W?
Eulimene pendula, *S. Wood.*
Lacuna (Eulimene) terebellata, *Nyst.*, D.
Rissoa curticostata, *S. Wood.*
Littorina littorea, *Linn.*
Natica catena, *Da Costa.*
— catenoides? *S. Wood.*
— clausa, *Brod.* and *Sow.*
— hemiclausa, *J. Sow.*
— multipunctata, *S. Wood.*
Vermetus intortus, *Lam.*, D?
Trochus cinerarius, *Linn.*, W? (the specimens are all slightly mutilated).
— Montacuti, *W. Wood.*
— tumidus, *Mont.*
— zizyphinus, *Linn.*, F, D.

[1] The absence of a capital letter after the name of a species means that that species is not derivative.

Fissurella Græca, *Linn.*
Emarginula fissura, *Linn.*
Calyptræa Chinensis, *Linn.*
Capulus Ungaricus, *Linn.*
Tectura virginea, *Möll.*
Dentalium dentalis, *Linn.*, F, D.
— entalis, *Linn.*, D? (worn).
Ringicula buccinea, *Broc.*, F, D.
Bulla cylindracea, *Penn.*, F.
Melampus pyramidalis, *J. Sow.*

Bivalvia.

Anomia, *sp.*
Ostrea, *sp.*
Pecten maximus, *Linn.*, F, D.
— opercularis, *Linn.*
— pusio, *Penn.*
Lima exilis, *S. Wood*, F, D, W?
Mytilus edulis, *Linn.*, F.
Arca lactea, *Linn.*
Pectunculus glycimeris, *Linn.*
— subobliquus, *S. Wood*, W.
— pilosus, *Linn.*, D.
Nucula lævigata, *J. Sow.*
— Cobboldiæ, *J. Sow.*
— nucleus, *Linn.*
Leda oblongoides, *S. Wood.*
Lucina borealis, *Linn.*
Diplodonta astartea, *Nyst.*
Cardita senilis, *Lam.*, D.
— scalaris, *Leathes.*
— chamæformis, *Leathes*, D (worn).
— corbis, *Phil.*
Cardium angustatum, *J. Sow.*
— decorticatum, *S. Wood*, D.
— edule, *Linn.*
— echinatum, *Linn.*
— Parkinsoni, *J. Sow.*
— venustum? *S. Wood.*
Astarte Basterotii, *de la Jonkaire*, F, D.
— Burtinii, *de la Jonkaire*, D.
— crebrilirata, *S. Wood.*
Astarte incrassata, *Broc.*, D.
— obliquata, *J. Sow.*
— Omalii, *de la Jonk.*, F, D.
— compressa? *Mont.*
Woodia digitaria, *Linn.*
Cyprina islandica, *Linn.*, F.
Venus casina, *Linn.*, F, D.
— fasciata, *Da Costa.*
Cytherea chione, *Linn.*, F, D.
— rudis, *Poli.*
Artemis lentiformis, *J. Sow.*, F, W.
Tapes pullastra, *W. Wood*, F.
— virgineus? *Linn.*, F.
Gastrana laminosa, *J. Sow.*, F, D.
Donax politus, *Poli*, F, D?
Psammobia, *sp.*, F, D.
Tellina obliqua, *J. Sow.*
— prætenuis, *Leathes.*
Mactra arcuata, *J. Sow.*
— ovalis, *J. Sow.*
Solen siliqua, *Linn.*, F.
— ensis, *Linn.*, F.
Corbula striata, *Walk.*
Corbulomya complanata, *J. Sow.*, W?
Saxicava arctica, *Linn.*
Panopea Faujasii, *Men de la Groye*, F, D.
Mya arenaria, *Linn.*, mostly F.
Pholas crispata. *Linn.*, F.
— cylindrica, *J. Sow.*, F, W?
Gastrochæna dubia, *Penn*, F, D.

[Mr. Robert Bell, who has of late years very assiduously searched the Walton beds, as well as examined several collections made by others from that locality, has kindly furnished the following list of all the molluscan remains which he has been able to detect there, beyond those given in the column for that place in my father's lists in the first Supplement to his work. The species to which an asterisk is affixed are additions to the mollusca of the Upper Tertiaries of the east of England, given in the previous part of this work, and are inserted solely on the authority of Mr. Bell.

Gasteropoda.

Erato lævis, *Don.*
Nassa labiosa, *J. Sow.*
— propinqua, *J. Sow.*
Buccinum undatum, *Linn*
Trophon consocialis, *S. Wood* (one specimen only, much worn, and probably derivative).
— gracilis, *Da Costa.*
— scalariformis, *Gould.*
Pleurotoma linearis, *Mont.*
— turrifera, *Nyst.*
— nebula, *Mont.*
— rufa? *Mont.*
Turritella planispira, *S. Wood.*
Chemnitzia communis,* ? *Risso.* (perhaps only a short form of *C. internodula.*)
Eulima subulata, *Don.*
Odostomia acuta, *Jeff.**
Natica catena, *Da Costa.*
— clausa, *Brod.* and *Sow.* (affinis. of *Gmel.*)
— varians, *Dujardin.*
Vermetus intortus, *Lam.*
Trochus formosus, *Forbes.*
— multigranus, *S. Wood.*
— Adansoni, *Payr.*
— tumidus, *Mont.*
— Kicksii, *Nyst.*
— Montacuti, *W. Wood.*
— zizyphinus, *Linn.*
Emarginula crassa, *J. Sow.*
Tectura virginea, *Müll.*
Dentalium dentalis, *Linn.*
— rectum, *Linn.*
Actæon subulatus, *S. Wood.*
— tornatilis, *Linn.*

Bivalvia.

Mytilus edulis, *Linn.*
Modiola phaseolina? *Phil.*
Nucula nucleus, *Linn.*
— Cobboldiæ, *J. Sow.* ?[1]
Nucula tenuis? *Mont.*
Cardita senilis, *Lam.*
Cardium fasciatum, *Mont.*
Cardium strigilliferum, *S. Wood.*

[1] My father collected extensively at Walton at intervals during forty years, and Mr. Robert Bell also very assiduously for many years past, without either of them having met there with the slightest trace of this shell, so common in the later part of the Red Crag; but Mr. Bell has lately met with a single worn valve in the collection made from Walton by Mr. Greenhill, of Vermont College, Clapton, on the authority of which the shell is inserted with a note of interrogation in the above list.

Cardium pinnatulum, *Con.* (nodosulum).
Astarte Galeotii, *Nyst.*
— Forbesii, *S. Wood.*
Circe minima, *Mont.*
Abra prismatica, *Mont.*
Mactra glauca, *Born.*
Tellina obliqua, *J. Sow.* (a fragment only by Mr. Bell, another fragment by Mr. Hy. Norton of Norwich, and a single valve by Mr. Greenhill.)
Mya arenaria, *Linn.*

The contrast thus shown by the Crag of Felixstowe to that at Walton Naze (seven miles distant from it) is very striking. At the former place such species as *Trophon costifer*, and *Nassa reticosa*, among Gasteropods, which abound at Walton, and are there preserved in the most perfect condition, are, though abundant, scarcely to be found unmutilated; and such very few examples of them as do occur but little broken are all more or less worn. Among the Bivalvia one of the most abundant shells at Walton, *Artemis lentiformis*, and which at that place is almost always perfect (though generally with valves detached), is, though very abundant, *invariably* in fragments at Felixstowe. That this fragmentary condition at Felixstowe can only arise from the presence of the shell in the Crag there being due to derivation from the destruction of anterior accumulations, is shown by the fact that while *A. lentiformis*, which is thus in fragments is a strong shell, the thin and fragile shell, *Tellina prætenuis* (a species unknown from the Walton bed but in tolerable abundance at Felixstowe) occurs almost always perfect. It is, in my opinion, abundantly clear that during the time which elapsed between the accumulation of the Walton beds of Red Crag and their destruction and re-accumulation to form the Red Crag of Felixstowe, such shells as *Trophon costifer*, *Nassa reticosa*, and *Artemis lentiformis*, as well perhaps as some others had ceased to live in the Red Crag sea; and that other shells such as the dextral form of *Trophon antiquus*, *Leda oblongoides*, *Tellina prætenuis*, to which might have been added *Nucula Cobboldiæ*, but for the solitary and somewhat uncertain occurrence mentioned in the footnote on p. 16, (all of these being species which endured into the early Glacial sea,) and probably some others which might be mentioned, had been introduced into it. Moreover, the extremely profuse shell of all the rest of the Red Crag and of the Lower Glacial sands, *Tellina obliqua*, but which had lived in the Coralline Crag sea, was during the Walton accumulation so scarce in the Red Crag sea that only a single valve of it and two fragments (by three separate collectors) have been detected there.

In the Red Crag of Butley the change becomes further marked, both by the greater frequency of these later introductions, and by the presence of arctic species, which have not yet been detected in the Crag of Essex or of the more southern part of Suffolk, the Upper Beds of the Red Crag having either been removed from, or else having never been formed in, that part of Suffolk.

The changes which led to the peculiar and exceptionally perplexing features thus presented by the beds of the Red Crag of England, with their large admixture of false

evidence afforded by derivations from beds anterior to that Crag, to a smaller extent also by derivations from earlier beds of Red Crag age, appear briefly to have been these.

At the incoming of marine conditions over part of England after the long interval of terrestrial conditions which had endured since the elevation and denudation of the Oligocene sea-bed, and when several of the tropical genera of Mollusca characteristic of the older tertiary time still lived in the sea of our latitudes, the older Pliocene submergence seems to have extended from the north of Belgium, over the south-east of England, and in that way formed a strait, connecting the North Sea with an arm from the Atlantic which extended over Touraine.[1] The evidences of the oldest accumulations of this strait which remain in England are probably some sands on the Chalk Downs between Maidstone and Dover, and (I think it likely) also an outspread of shingle along the strait's northern shore, of which patches remain on the Lower Bagshot outliers of South Essex, and of the Isle of Sheppy,[2] and sweep over the edges of some of these on to the uppermost beds of the London Clay there, as well as of a patch of the same shingle crowning the middle part of the London Clay on Shooters Hill, in north-west Kent, and possibly some others on the chalk of North Surrey, near Caterham. Changes took place in the distribution of the land and water of this strait, and the Coralline Crag ensued. Except over a part of Belgium, and (deeply buried under more recent beds) probably a part of Holland also, the oldest beds of this Pliocene Strait have been almost entirely removed by the later action of the sea, and numerous remains of the marine animals, both vertebrate and invertebrate, which were entombed in them have, in consequence, got into the Red Crag, particularly the nodule bed at its base. Remnants of the Coralline Crag, however, remain near each extremity of this Strait, viz. in Normandy near the one, and in Suffolk near the other end, besides a more general

[1] The French geologists still apply the term "Miocene" to the Faluns of Maine et Loire and of Touraine, although these Faluns appear to be coeval with beds in Belgium to which several of the geologists of that country apply the term "Pliocene," insisting that the "Miocene," *i. e.* the marine equivalent for the terrestrial interval between the "Oligocene" and the oldest "Pliocene," is not represented by any marine deposits there. To avoid as much as possible adding to this confusion, especially as the oldest part of the English Crag—the Coralline—is clearly "Pliocene," I have avoided in the text the use of the word "Miocene." The beds of Maine et Loire and of Touraine not only contain many shells of the Coralline Crag which do not appear to be survivors from the older Tertiary seas of England and France, but also living British shells, such as *Murex erinaceus*, which do not appear to have entered British seas until the time of the Red Crag, or, such as *Nassa reticulata*, even until the Glacial submergence.

[2] See 'Quart. Journ. Geol. Soc.,' vol. 24, p. 464, and bed No. viii, of the plate in vol. 36, p. 457. Prof. Prestwich, in a paper "On the Extension into Essex, Middlesex, and other inland counties, of the Mundesley and Westleton Beds," read before the Brit. Assoc. in 1881, appears to refer the shingle mentioned in the text as occurring on the Lower Bagshot outliers to the Lower Glacial pebbly sand (No. 6 of the beds described in the "Introduction" to the first Supplement to the Crag Mollusca); from which view, as well as from others in the same paper, I differ. My own view of the events which took place during the Newer Pliocene period in England is given in a memoir of which the first part is published in the 36th volume of the 'Quarterly Journal of the Geol. Soc.,' p. 457.

outspread in Belgium. By the gradual emergence of this strait the sea in Belgium and East Anglia, at the time represented by the Red Crag, *i.e.* the commencement of the Newer Pliocene period, had become separated by land from that in Normandy, but the molluscan remains which it has left in the latter country closely agree with those of the older portions of the Red Crag of East Anglia.[1] One of the results of this separation seems to have been to cause, on the English Coast of the North Sea, a great rise and fall of the tide over a very shallow and flat bottom. As this tide surged round the low island of Coralline Crag at Sutton, and also round the peninsula of the same Crag formed by the parishes of Sudbourn, Orford, and Aldboro' (the rest of the Coralline Crag, with some small exception, having been destroyed either during emergence by the sea which deposited it or by the inroad of the Red Crag water), it carried from that Crag a large quantity of its Molluscan remains which thus became mixed with the remains of the Mollusca then living in this sea, so that the banks of Red Crag, which were then accumulating in South Suffolk, became full of such derivatives, while the bed at Walton, being more distant from that island and peninsula, was left almost entirely destitute of organisms of this extraneous origin.

Formed under these conditions, and accumulated as banks or foreshores between high and low-water mark, as their peculiarly continuous highly oblique bedding attests, the marine beds of the Red Crag (with the exception of the latest or Chillesford beds of that formation, which accumulated during a slight depression of the area at the close of the Crag,) were continuously undergoing destruction and reaccumulation; and successive accumulations of them, formed between tide marks, may be seen in some sections laid up at the foreshore angle of bedding, one upon another. Thus the changes in the molluscan life of the North Sea, which from the approach of the glacial period were taking place during the Red Crag, have become obscured by the circumstance that the remains of mollusca which had died out (in that sea at least) were, in consequence of the destruction of these older banks, and the reaccumulation of the material of them in new banks of the same character and mode of deposit, mixed up with those of the mollusca still surviving there, and of some new forms which the change of climate, and probably distant geographical changes also, were bringing in; this mixed accumulation being further complicated by the introduction of molluscan remains from the Coralline Crag and still older formations.

[1] See 'Étude Geologique sur les Terrains Crétaces et Tertiares du Cotentin,' par. MM. Viellard and Dollfus, Caen, 1875, pp. 148—163. The material of these beds of the Cotentin referable to the Coralline Crag (*Conglomérat à térébratules*), of which Mr. Harmer brought me some from St. Georges de Bohon, near Carentan, appears undistinguishable, both in mineral character and included organisms, from the Upper Beds of the Coralline Crag, at Sudbourn.

I take this opportunity of correcting the representations given by Mr. Harmer and myself of the beds of the Crag district in the map, and sections which accompany the "Introduction" to the first Supplement to the Crag Mollusca in the volume of the Society for 1871, so far as subsequent observations have rendered necessary, as follows:

Owing to the obscurity existing where sand rests on sand, the Lower Glacial sand, No. 6 of the map, is not shown further south than the neighbourhood of Dunwich; and in the section (A) through the Red Crag area it is omitted altogether, and the Middle Glacial (No. 8) represented as resting throughout on the Red Crag. Residence in the district since 1873 has afforded me the means of a closer examination and comparison of pit sections there, and convinced me that this representation (which was mine only) was erroneous, and that the sand No. 6 is not only present, but is the principal formation in this area; for though it is mostly underlain by Red Crag, it in many places takes the place of this, and rests direct on the London Clay. Over the Red Crag, however, there is in some excavations a reddish-brown sand, soft, loamy, and destitute of the smallest fragment of shell, but in which sometimes masses of shelly crag are enveloped, and in which, in some rare instances, bands of ironstone containing casts of Red Crag shells also occur. This sand is merely the Red Crag from which the calcareous constituents have been carried away by dissolution in water, while the argillaceous and ferruginous constituents have been either left unaffected, or else redeposited in the undisturbed sandy mass. The difficulty, therefore, is to distinguish between this and the sand No. 6; for in South Suffolk the latter loses the shingly or pebbly character which enables it to be easily recognised in North East Suffolk and in Norfolk. Over the Red Crag area the sand No. 6 passes upwards by the mere substitution of argillaceous for arenaceous sediment into stratified brickearth, just as it does on the Cromer Coast and generally in North Norfolk, though from its geographical position in South Suffolk this brickearth has not there received that copious intermixture of chalk *débris* and chalk silt which along the Cromer Coast (where it is represented by the "Contorted Drift," bed No. 7 of the Map, &c.) forms its preponderating constituent, in proportion to the diminution in its distance from the Lincolnshire Chalkwold, from the degradation of which by the land ice during the earlier part of the Glacial period, when England was undergoing its great submergence, this *débris* and silt were derived; but thin layers of this *débris* are sometimes present in it in South Suffolk, as *e.g.* at Kesgrave. Neither has it been so disturbed by the action of grounding bergs as in North Norfolk, where the result of this action has obtained for it the name of "Contorted Drift;" nevertheless, it is sometimes contorted in Suffolk, as I observed in an excavation of it beneath the chalky clay on the Hasketon side of Woodbridge in 1874. Over the Red Crag area this bed has suffered so generally and extensively from the wash of the sea during the emergence of the country, when the Middle Glacial gravel (No. 8) was in course of accumulation, and the land ice, of which the chalky clay was the moraine, was extending from the Wold to follow the retiring sea, that only patches of it remain there. One of these patches, that

at Kesgrave, is shown in the map, but another occurs at California-by-Ipswich, another at Kirton, and another at Rookery Farm, Eyke, none of which are shown in it. All of these appear to be of considerable thickness (40 to 50 feet), and the first and last of them have a little of the Middle Glacial gravel over them in places. Another patch, on the Hasketon side of Woodbridge, is overlain by the chalky clay; and at Tuddenham, near Ipswich, the base of this brickearth is exposed passing down into the sand No. 6, of which about twenty feet underlies it, and rests on the London Clay; and there also the denudation of this brickearth, which took place prior to the deposit on it of the Middle Glacial gravel, is well shown by the irregular way in which that gravel lies upon it. Remnants occur also in other parts of South Suffolk, but they are beyond the limit of the map.[1] In the Section (A) drawn through the Red Crag area, the Middle Glacial is therefore erroneously represented as resting generally on the Red Crag, whereas this is exceptional, and the Lower Glacial sands should have been shown in most parts (*i.e.* in those where they have not taken the place of the Crag altogether) as intervening, and the thickness of the Middle Glacial been there proportionately reduced. The correct position of all the beds of this sequence is shown in fig. 1 of the plate which accompanies my memoir on the "Newer Pliocene Period in England," in the thirty-sixth volume of the 'Quarterly Journal of the Geological Society,' the line of which is drawn through three of these remnants of the brickearth; and in it the Middle Glacial gravel is shown on the plateaux as very thin, and in places absent altogether, but as thickening towards the brows of the valleys, which, when they were in the condition of troughs excavated in the rising sea bottom of the sand No. 6, had been filled by it; the gravel in the central parts of these troughs having been cut out as these were deepened by the shrinkage into them of the ice of the chalky clay, or by the action of the sea, as emergence went on. A well which I sunk to a depth of eighty-four feet subsequently to the publication of that figure, but on the exact line of it, and on the eastern edge of the plateau from which the valley of the Deben is cut down, showed this gravel to be there seventy feet thick beneath six feet of the chalky clay (the upper thirty feet being full of the chalk *débris* of that clay), and that the sands No. 6 had been almost all removed to give place for it. It is this sand, or else that formed by the decalcification of the Crag, and not the Middle Glacial, which overlies the Crag shown in the cut on page xxi of the "Introduction" and in Sections XIX and XX.

The map thus requires to be corrected by the intercalation of a belt of the shade and colour representing the sand No. 6 between the Red Crag and the Middle Glacial; and it

[1] One of these, at Stowmarket, is in the footnote to p. 22 of the "Introduction," referred to as of post-glacial age, and another about six miles north of Ipswich, and three-quarters of a mile south-west of Hemingstone Church, is shown in the map by a dot of the wrong colour (that of bed No. 10). I am informed also by Mr. Dalton, of the Geological Survey, that he found an exposure of this brickearth under the chalky clay at Baddingham, just midway between the patch of it shown in the map at Blaxhall, in South-east Suffolk, and the exposure of it at Withersdale, on the Waveney, near Harleston, so that probably much of the chalky clay of High Suffolk is underlain by remnants of the same bed.

also requires the substitution of this colour for that of the Middle Glacial over most of the area east of the chalky clay, which stretches from Sizewell to the River Blyth, and to the cliffs of Easton Bavent and Covehithe; there being but very little, if any, of the Middle Glacial present over this area, which is occupied by the sand and shingle No. 6 in greater thickness than elsewhere.

The Section (R) of Dunwich Cliff, and that (S) of Easton Bavent and Covehithe Cliffs, also require correction, the bed shown in the latter as the Contorted Drift (No 7) being the same as the capping loam of Dunwich Cliff, which in Section R is shown under the number 10;[1] both of them being, as a late examination of them has enabled me to perceive, a morainic bed formed (in Dunwich and the southern part of Easton Cliffs, from a reconstruction of the pebbly sand No. 6 with some admixture of the material of the chalky clay, and in the northern part of Easton Cliff, from a reconstruction of these sands and the Chillesford clay together,) by the ice in its passage to the sea after this part of Suffolk had emerged towards the close of the chalky clay formation; and the gravel, shown by the number 10, as resting on this bed and on the Chillesford clay in this cliff, and shown also in Covehithe Cliff, is merely a part of this morainic bed, being pots of pebbles derived from No. 6. A bed of this morainic material cutting like a dyke through the sands No. 6 at the southern end of Easton Cliff (where this cliff is only six or seven feet high) requires to be added to Section S. Another such bed forms the northern extremity of Southwold Cliff, overlying the bed of derivative shells in the shingly sand No. 6, presently to be referred to. The section of Dunwich Cliff also requires correction by the omission of the Middle Glacial which is shown in it under the numbers 8″, 8‴, and 8⁗; all of this being part of the sand No. 6, to which the shingle under the ruins (shown in Section R by the figure 10) also belongs; and this shingle is still more largely present in that sand at the southern end of this cliff. The whole of Dunwich Cliff, from below the beach line up to the capping loam of morainic origin just mentioned, is thus formed of No. 6, the intercalation of clay shown in Section R by the figure 9 being probably a modification of the sandy formation, by the introduction of argillaceous material analogous to that which gave rise to the Cromer Till and Contorted Drift of North Norfolk; both of which are, in my view, merely modifications of the same shingly sand by the introduction of a different sediment.

Descending thus below the beach line, and forming (with the morainic loam already mentioned) the whole of the cliffs of Dunwich and Southwold, this sand there occupies a space from which the Chillesford clay and the upper part of the Crag beneath it had been removed, so as to form a channel in the Lower Glacial sea which divided two islands formed of Chillesford clay and Crag beds; of which islands the southern was comprised by the country extending from Butley and Chillesford to Sizewell, and the northern by the area of which the cliffs of Easton and Covehithe (Sect. S) furnish a section. The sands No. 6, which, as already mentioned, cover the Red Crag area, lie up to the

[1] See the footnote No. 5 to p. 29 of the "Introduction."

southern of these two islands, as well as extend over it, just as they do in the case of the northern, and so that, being bedded in the channel and up to the shore of this southern island, they lie much below the level of the Chillesford beds which cap it at Chillesford, Sudbourne, Iken, Oxford, and Aldboro', as well as below much of the Coralline and Red Crag on which those beds there rest, and of which that island is formed.[1] Occupying also the channel dividing these islands from each other, and in that way furnishing the section of Dunwich and Southwold Cliffs, these sands lie up to the shore of the northern island thus formed of beds of Crag age, as may be seen in the southern part of Easton Cliff when this is sufficiently free from talus. It is in this part that a bed of shells occurs in these sands, and it is the only one, so far as I am aware, that they yield in Suffolk. This shell bed is exposed at the northern end of Southwold Cliff, about the beach level, and immediately under the morainic loam already mentioned;[2] and I call attention to it because I believe that *all* the shells in it are derivatives from the Crag of which this Lower Glacial island was formed, before the progress of the submergence overwhelmed it, in a similar way to that in which so large a part of the shells in the Red Crag are derivatives from the island and peninsula of Coralline Crag which existed in the Red Crag sea. Not only is the characteristic species of these sands in Norfolk, *Tellina Balthica*, not present in this bed, but the shells that are in it, even the strongest, such as the Littorinæ, are for the most part fragmentary. The shells which I was able to detect in it during many repeated searches were the following, viz. *Nassa incrassata*, *Purpura lapillus*, *Cerithium tricinctum*, *Turritella*

[1] The southern of the two islands mentioned in the text may have been divided into three smaller, by channels now represented by the mouth of the Alde and by the Butley creek, in which these Lower Glacial sands may have been bedded and since removed; for at Iken Cliff, on the Alde, these sands are in section at the sea level, nearly fifty feet below the contiguous top of the Chillesford beds on this island. This southern island (or islands) was probably abutted on the south by another island formed of Red Crag, and now buried beneath the Lower Glacial sand (capped with more or less of the Middle Glacial gravel) of the heaths of Hollesley, Boyton, Sutton, and Alderton; for exposures of Red Crag along the edges of the small valleys penetrating this tract of country occur at as high or even higher level than the Chillesford beds just referred to. This, again, was probably divided by a channel now represented by the Deben from another island of Red Crag, represented by the tract between the Deben and Orwell estuaries, and this again by one represented by the tract between the Orwell and Stour estuaries; as from the way in which the Lower Glacial sands take the place of the Crag in many parts along the sides of the valleys of these estuaries, these latter may very likely have been channels during the earlier part of the Lower Glacial sea, and been once filled by its sands, which were removed by the action of the sea, followed up by the land ice as the land was emerging during the formation of the chalky clay. Whether the Chillesford clay ever was spread out over that part of the Red Crag which occupies the area between Butley and the Stour, and was afterwards removed, or whether this southern part of the Red Crag was land during the slight depression under which the Chillesford beds were spread out, there are no means of determining, though the Chillesford clay seems to have been deposited in north-east Essex (Walton), and up the Gipping valley at Needham.

[2] This bed was also found about half a mile inland in making the railway cutting near Southward station.

terebra, *Littorina littorea*, *Natica clausa*, *Leda oblongoides*, *Lucina borealis*, *Cardium edule*, *Astarte compressa*, *Cyprina islandica*, *Tellina obliqua*, *Corbula striata*, and *Mya arenaria*; all being species which occur in the adjacent Crag beds.

The fluvio-marine Crag from which the Chillesford beds have been removed to form this channel, and on which the sands No. 6 thus rest below the beach line, comes through the beach in two very small knobs about a quarter of a mile from the southern end of Dunwich Cliff, which are crowded with shells; and it yielded me also an equine tooth.

Lastly, I have in the memoir of the "Newer Pliocene Period" in England, already referred to, given my reasons for regarding the Bridlington bed from which the Mollusca given in the "Upper Glacial" column of the tabular list at the end of the first Supplement to the "Crag Mollusca" were obtained, and also the basement clay of Holderness with which that bed is associated, as being of Lower Glacial age, such clay being, in fact, the actual moraine of the ice from which proceeded the material interstratified in the Cromer Till (No. 6 *a* of the Map, &c.); and for regarding the molluscan remains given in the "Middle Glacial" column of the same tabular list, as being an admixture of remains from the bottom of some fiord which had been in process of accumulation from the commencement of the sands No. 6, and during the whole of the Glacial submergence, but which was ploughed out by the ice of the chalky clay during its advance as it followed the retreating sea during emergence; so that these remains became embedded by this derivative process in the upper part of the Middle Glacial (No. 8 of the Map and Sections), as that bed was emerging, and just before the chalky clay moraine was pushed over it.

I should add that though, to avoid confusion in this explanation, I have adhered to the term Middle Glacial, this formation is (in the view to which the continued study of the subject has brought me) merely the marine accumulation which was synchronous with the moraine of the land ice which is represented by the chalky clay; and the precise mode in which the two were accumulated, according to my view, is traced in detail in the memoir just referred to.]

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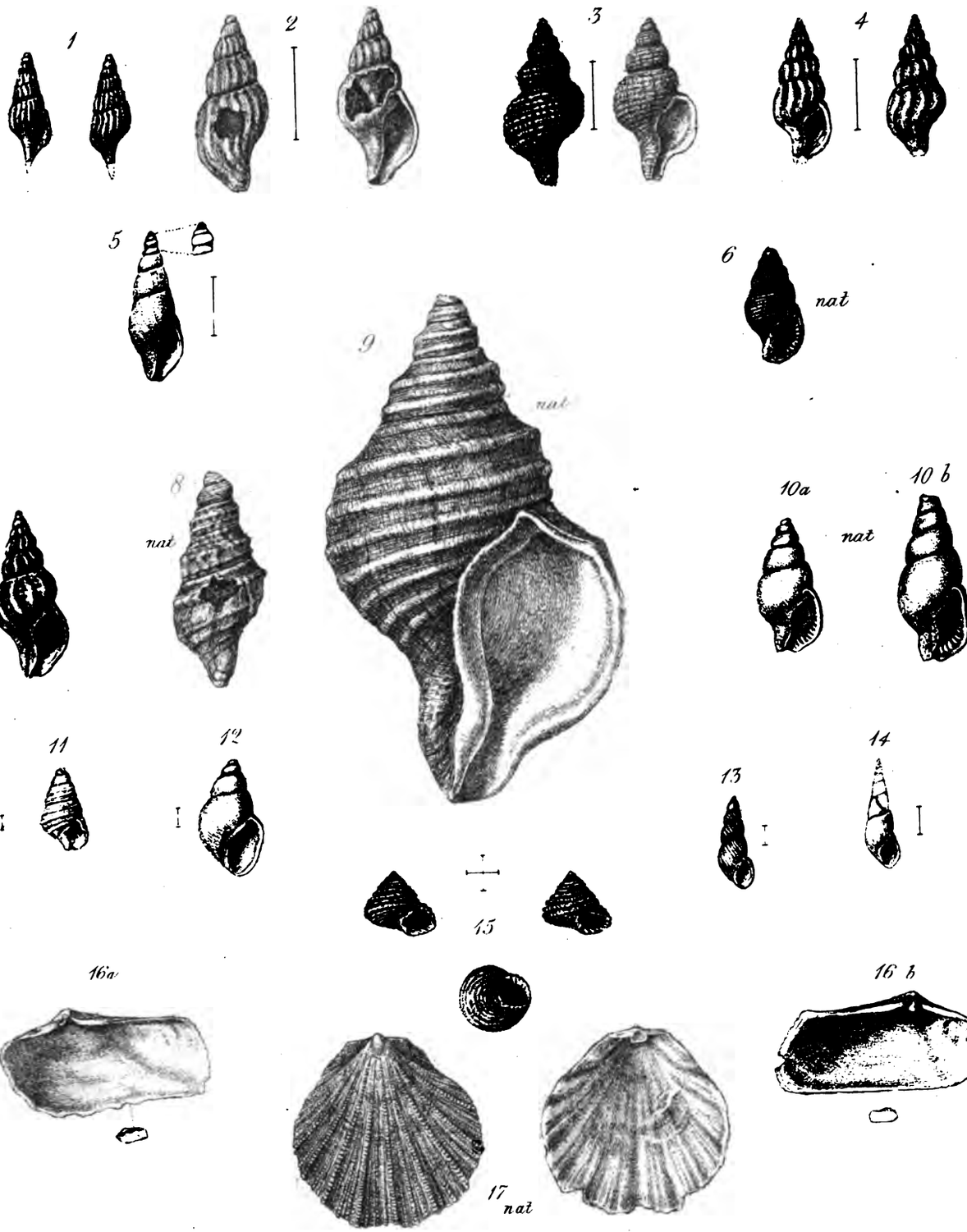
PLATE I.

Fig.	*Names of the shells.*	page	*Localities from which the specimens figured were obtained.*
1.	*Rostellaria? gracilenta* (nat. size)	1	Red Crag, Felixstowe (derived).
2.	*Raphitoma submarginata* (enlarged)	5	Red Crag, Felixstowe (derived).
3.	*Trophon muricatus*, var. *exossus* (enlarged)	3	Red Crag, Felixstowe.
4.	*Pleurotoma harpula* (enlarged)	5	? Crag, Boyton.
5.	— *gracilior* (enlarged)	4	Red Crag, Walton Naze.
6.	*Columbella abbreviata* . . .	6	Red Crag, Foxhall.
7.	*Pleurotoma nebula* (enlarged).	4	Red Crag.
8.	— *turris* (nat. size) .	3	Red Crag, Felixstowe (derived).
9.	*Trophon antiquus*, var. *despectus* (nat. size) . . .	2	Red Crag, Sutton.
10, *a*.	*Columbella erythrostoma?* (nat. size) .	6	Red Crag, Butley.
10, *b*.	— — *?* (nat. size) .	6	Red Crag, Butley.
11.	*Menestho Suttonensis* (enlarged)	9	Cor. Crag, Sutton.
12.	*Odostomia Reevei* (enlarged) .	9	Fluvio-marine Crag, Bramerton (derived?)
13.	*Nodostoma ornata* (enlarged)	8	Cor. Crag, Sutton.
14.	— *eulimelloides* (enlarged)	8	Cor. Crag, Sutton.
15.	*Margarita crassi-striata* (enlarged)	10	? Crag, Boyton.
16, *a*.	*Siliquaria parva* (enlarged) .	11	Fluvio-marine Crag, Bramerton (derived?)
16, *b*.	— — (enlarged) .	11	
17.	*Pecten disparatus* (nat. size) .	12	Red Crag.



G.B. Sowerby.